

Use of smokeless tobacco: blood pressure elevation and other health hazards found in a large-scale population survey

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Abstract. Bolinder GM, Ahlborg BO, Lindell JH (Department of Medicine, Karolinska Hospital, Stockholm, and Research Foundation for Occupational Safety and Health in the Swedish Construction Industry, Danderyd, Sweden). Use of smokeless tobacco: blood pressure elevation and other health hazards found in a large-scale population survey. *Journal of Internal Medicine* 1992; 232: 327–334.

Health hazards associated with the use of smokeless tobacco were evaluated in a cross-sectional study of 97 586 Swedish construction workers undergoing health examinations in 1971–74. All users of smokeless tobacco only (5014 subjects) and all exclusive smokers of ≥ 15 cigarettes daily (8823 subjects) were compared with all non-users of any tobacco (23 885). Both smokeless tobacco users and smokers showed higher prevalences of circulatory and respiratory disorders. Hypertension was most common in smokeless tobacco users. In the 45- to 56-years age group, the odds ratio for a diastolic blood pressure of > 90 mmHg was 1.8 (95% CI, 1.5–2.1), and for a systolic blood pressure > 160 mmHg, 1.7 (95% CI, 1.3–2.1). Smokers showed the lowest prevalence of hypertension. Disability pensions due to cardiovascular disease were nearly 50% more frequent in both smokeless tobacco users and smokers. These findings indicate that an increased cardiovascular risk is also associated with the use of smokeless tobacco.

Keywords: blood pressure, body mass index, cardiovascular diseases, peptic ulcer, smoking, tobacco: smokeless.

Introduction

Sweden has the highest consumption of smokeless tobacco per capita in the world. A total of 800 000 individuals consumed 4632 tons of smokeless tobacco in 1990 [1].

The acute cardiovascular effects of tobacco smoking have been mainly attributed to nicotine, which causes an increase in heart rate, blood pressure, cardiac output, stroke volume, coronary blood flow, arrhythmia and electrocardiographic changes [2]. However, many studies have shown lower average blood pressure levels among smokers than among non-smokers [3–6]. Carbon monoxide [7] and nicotine [8] might have a synergistic negative effect on the vascular endothelium. The mechanisms whereby constituents of tobacco promote the vascular disease processes are not clear [8–10].

The exposure to nicotine associated with smokeless tobacco is high relative to that associated with smoked tobacco [11, 12]. In Sweden the average consumption [13] for a daily snuff taker is 16 g d^{-1} , and for a smoker 13 cigarettes daily, which is equivalent to a nicotine dose of *c.* 30 mg d^{-1} , for the oral snuff user, compared to *c.* 18 mg d^{-1} for the smoker.

Apart from cardiovascular risks, the nicotine content of smoked tobacco has been associated with many other health hazards [2, 14], for example a higher incidence of peptic ulcers [15, 16], and degeneration of the vertebral column and vertebral discs [17–19].

The smokeless tobacco used is mainly moist snuff (finely ground dark tobacco leaves moistened with water and buffered to a pH of about 8.5 with sodium chloride and sodium carbonate). The 'pinch' is

usually placed in contact with the oral mucosa behind the upper lip. The average usage time has been estimated to be about 10 h d⁻¹ for a daily snuff user [20].

The aim of the present study was to investigate the relationship between tobacco consumption habits and health status. A specific aim was to compare the users of smokeless tobacco with non-users and cigarette smokers by studying reported symptoms from different organs, blood pressure, body mass index, sick leave statistics, and the allocation of disability pensions. It was hoped that the results of the study would lead to an increased knowledge of the general health hazards associated with use of smokeless tobacco.

Methods

Subjects

The Swedish Construction Industry's Organization for Working Environment Safety and Health was established in 1968. All construction workers, electricians, painters, and sheet-metal workers 16–65 years of age are enrolled for regular voluntary health check-ups every other year. Other employees in the construction industry are also offered this service. In 1974 there were 183 865 registered workers in the Swedish construction industry.

The present investigation is a cross-sectional study based on the examinations performed during 1971–74. A total of 135 020 individuals had medical check-ups during this period. In order to improve the reliability, the study population was confined to construction workers, so that a total of 97 586 men were available for the study.

About 25% of the workers did not report for the health examination. The invitation is routinely sent out by the construction site staff, and there is no record of whether the workers were not contacted or were unwilling to attend.

Procedures

Each subject was examined by a nurse according to a standardized protocol, either in a mobile health unit at or near the work site, or at a medical health centre. A questionnaire containing questions about type of occupation, tobacco use (type, amount and duration for smoked tobacco and duration for smoke-

less tobacco users), and yes/no questions concerning symptoms and disorders involving various organ systems, was completed together with the nurse. The last intake of tobacco was not recorded, but no subject was allowed to smoke or use smokeless tobacco in the waiting room or during examination. Body weight and height were determined. Pulse rate and blood pressure were measured after 5 min of rest in the supine position, using a standard mercury manometer on the upper arm. Blood pressure was recorded to the nearest 2 mmHg.

Information about sick-leave frequency and disability pension diagnoses was obtained from the Swedish National Social Insurance Board, where all persons aged ≥ 16 years and domiciled in Sweden are registered, and those with a qualifying annual income (1990, more than S1000) are insured for sickness cash benefits.

In the study cohort of 97 586, those who had never used any type of tobacco ($n = 23 885$, or 24.5%) were compared with subjects who reported daily use of smokeless tobacco (dose not recorded) and who had never been regular smokers ($n = 5014$, or 5.1%) and with subjects who smoked ≥ 15 cigarettes daily and had never been regular smokeless tobacco users ($n = 8823$, or 9.0%). All subjects with a mixed tobacco consumption, or who were ex-smokers, were excluded from the study ($n = 59 864$).

Relative risks and prevalence odds ratios, together with 95% confidence intervals (C.I.), were calculated [21]. In the analysis, account was taken of potential confounding factors regarding age (age groups 16–35, 36–45, 46–55, and 56–65 years). The body mass index (BMI) was calculated as body weight/(height)².

Results

Symptoms

Data for the health examinations of 37 722 persons were analysed. Table 1 shows the age-adjusted prevalence of symptoms and odds ratios with confidence intervals for each symptom, on comparing smokeless-tobacco users and smokers with non-users. The four age groups were also analysed separately. All symptoms except 'heart burn' were reported more frequently in the older age categories in each tobacco habit group, and the increase in prevalence ranged according to symptoms, between twofold and up to 12-fold on comparing the oldest

Table 1. Prevalence of questionnaire-reported symptoms, adjusted for age, expressed as a percentage for non-users and as odds ratios with 95% confidence intervals for smokeless tobacco users and smokers, compared to non-users

Symptom	Non-users (n = 23885)*		Smokeless tobacco users (n = 5014)*		Smokers ≥ 15 cig/day (n = 8823)*	
	%	OR	OR	C.I.	OR	C.I.
Cough in the morning	3.0	1.0	2.1	(1.8–2.4)	7.9	(7.2–8.5)
More than 3 months' cough/year	2.1	1.0	1.4	(1.1–1.7)	6.2	(5.5–6.8)
Breathlessness on slight effort	4.1	1.0	1.4	(1.3–1.6)	2.5	(2.2–2.7)
Chest pain walking uphill	3.7	1.0	1.2	(1.1–1.4)	1.8	(1.7–2.1)
Pain in the leg while walking	2.5	1.0	1.3	(1.1–1.5)	2.1	(1.8–2.4)
White finger symptoms	6.9	1.0	1.4	(1.3–1.6)	1.6	(1.5–1.8)
Heartburn	19.4	1.0	0.9	(0.8–0.9)	1.3	(1.3–1.4)
Peptic ulcer	3.6	1.0	1.1	(0.9–1.2)	2.8	(2.5–3.1)
Sleeping disturbances	5.6	1.0	1.2	(1.1–1.4)	1.8	(1.7–2.0)
Nervous problems	4.6	1.0	1.2	(1.1–1.4)	1.8	(1.6–2.0)
Low back pain in the past year	22.0	1.0	1.1	(1.0–1.2)	1.2	(1.2–1.3)

* Numbers in parentheses refer to all subjects in the tobacco habit group.

Table 2. Disability pension—total number of cardiovascular and musculoskeletal diagnoses in the different tobacco habit groups, and odds ratios with 95% confidence intervals for smokeless tobacco users and smokers, compared to non-users in the 46–55 and 56–65 year age groups

Diagnosis	Age (years)	Non-users (n = 23885)*		Smokeless tobacco users (n = 5014)*			Smokers ≥ 15 cigarettes d ⁻¹ (n = 8823)*		
		n	OR	n	OR	C.I.	n	OR	C.I.
Cardiovascular diagnosis	46–55	30	1.0	8	1.6	(0.7–3.5)	22	2.2	(1.3–3.9)
Cardiovascular diagnosis	56–65	149	1.0	69	1.5	(1.1–1.9)	33	1.3	(0.9–1.9)
Hypertension†	46–65	38	1.0	28	3.0	(1.9–4.9)	9	0.9	(0.4–1.9)
Musculoskeletal diagnosis	46–55	43	1.0	20	2.8	(1.6–4.8)	34	2.4	(1.5–3.8)
Musculoskeletal diagnosis	56–65	318	1.0	149	1.5	(1.2–1.8)	91	1.7	(1.3–2.2)
All diagnoses		764		319			287		

* Numbers in parentheses refer to all subjects in the tobacco habit group.

† Hypertension is analysed in the 46–65 year age group as a whole due to the small total number of cases.

subjects with the youngest in the same tobacco group. The greatest difference between young and old age categories was seen in circulatory symptoms.

Sick leave and disability pension

The age-adjusted relative risk for frequent sick leave (1 d or more for four or more times in 1 year), including all kinds of diagnosis, was 1.7 (C.I., 1.6–1.8) for smokers and 1.1 (C.I., 1.0–1.2) for smokeless tobacco users compared to non-users. It was more common among younger workers than among older ones.

Longer sick leave (≥ 30 d in 1 year) occurred twice as often in older age groups than in younger ones both in tobacco users and in non-users. The overall

age-adjusted risk for smokers was 1.7 (C.I., 1.6–1.8), and that for smokeless tobacco users was 1.2 (C.I., 1.1–1.2), compared to non-users.

There was a total of 11 959 disability pensioners in the Swedish construction industry during the period of the investigation and 4259 (35%) of these subjects reported for the health examination. A total of 1370 subjects were found in the tobacco groups analysed. Musculoskeletal disorders accounted for 664 (48%) of cases, and circulatory diseases accounted for 314 (23%) of cases, as shown in Table 2.

Among the pensioners aged 46–55 years, smokers were found to have a relative risk of 2.3 (C.I., 1.7–3.1) for all diagnoses, and smokeless tobacco users had a relative risk of 2.5 (C.I., 1.7–3.5) compared to non-users.

Table 3. Body mass index (BMI, kg m⁻²): prevalence, as a percentage, of underweight (BMI < 22) and overweight (BMI > 26) in different age groups in non-users, and odds ratios with 95% confidence intervals for smokeless tobacco users and smokers, compared to non-users

Age (years)	Non-users %	Smokeless tobacco users		Smokers ≥ 15 cigarettes d ⁻¹	
		OR	(95% C.I.)	OR	(95% C.I.)
BMI < 22					
≤ 35	32.7	1.0	(0.9–1.1)	1.3	(1.2–1.4)
36–45	15.6	1.0	(0.7–1.2)	1.5	(1.3–1.7)
46–55	9.8	1.0	(0.8–1.3)	2.2	(1.9–2.6)
≥ 56	9.4	1.1	(0.9–1.3)	2.9	(2.4–3.6)
BMI > 26					
≤ 35	15.8	1.1	(0.9–1.2)	1.0	(0.9–1.1)
36–45	31.9	1.3	(1.1–1.5)	0.9	(0.7–1.0)
46–55	43.3	1.5	(1.3–1.7)	0.7	(0.6–0.8)
≥ 56	46.8	1.2	(1.1–1.4)	0.5	(0.4–0.6)

Both cardiovascular and musculoskeletal disorders accounted for excess risks as the cause of disability pension for both smokers and smokeless tobacco users, and this was most marked in the middle age group (46-55 years). Hypertension, a rare diagnosis

as a cause of disability pensioning, occurred in 38 non-users, 28 smokeless tobacco users and 9 smokers, implying a threefold higher risk for smokeless tobacco users, and no excess risk for smokers.

Body mass index (BMI)

The prevalence of underweight, defined as BMI < 22, in smokers was significantly higher than in non-users of tobacco, and this trend was found to become more accentuated with increasing age (Table 3). Smokeless tobacco users did not differ from non-users in the prevalence of underweight.

Overweight, defined as BMI > 26, was slightly more common among smokeless tobacco users, particularly in the middle-aged and old age groups (46-55 and 56-65 years).

Blood pressure and heart rate

Blood pressure values were dichotomized into systolic blood pressure > 160 mmHg or lower, and diastolic blood pressure > 90 mmHg or lower, and were also correlated with the BMI (see Tables 4 and 5). Blood pressure and heart rate data were lacking for 0.2% of the subjects.

Table 4. Prevalence of diastolic blood pressure > 90 mmHg in different tobacco groups according to age and body mass index (BMI), expressed as total number and percentage for non-users, and as total number and odds ratios with 95% confidence intervals for smokeless tobacco users and smokers, compared to non-users. Each age group is analysed without checking for BMI (total), as well as for three BMI categories (< 22 = thin, 22-26 = normal, > 26 = obese)

Age (years)	Non-users (n = 23835)*		Smokeless tobacco users (n = 5002)*			Smokers ≥ 15 cigarettes d ⁻¹ (n = 8797)*		
	%	n	n	OR	(95% C.I.)	n	OR	(95% C.I.)
16-35 (total)	2.5	250	71	1.3	(1.0-1.7)	100	0.9	(0.7-1.1)
thin	0.4	40	12	1.3		18	0.8	
normal	1.2	122	30	1.1	(0.7-1.7)	44	0.9	(0.6-1.2)
obese	0.9	88	29	1.4		38	0.9	
36-45 (total)	11.4	558	79	1.3	(1.0-1.6)	164	0.8	(0.6-0.9)
thin	0.9	44	8	1.7		17	0.7	
normal	4.6	226	29	1.3	(0.8-1.9)	69	0.8	(0.6-1.1)
obese	5.9	288	42	1.1		78	0.7	
46-55 (total)	26.8	1204	298	1.8	(1.5-2.1)	333	0.8	(0.7-0.9)
thin	1.7	76	11	0.8		47	0.9	
normal	10.0	448	96	1.9	(1.5-2.5)	117	0.8	(0.5-1.1)
obese	15.1	680	191	1.7		169	0.9	
56-65 (total)	38.8	1675	625	1.3	(1.1-1.4)	225	0.7	(0.5-0.8)
thin	2.4	105	42	1.2		40	0.8	
normal	14.4	621	202	1.3	(1.0-1.5)	88	0.7	(0.5-0.8)
obese	21.9	949	381	1.2		97	0.8	

* Numbers in parentheses refer to all subjects in the tobacco group for whom blood pressure data were available.

† For the 'thin' and 'obese' groups, confidence intervals have been calculated but are omitted from the table for clarity.

Table 5. Prevalence of systolic blood pressure > 160 mmHg in different tobacco groups according to age, expressed as total number and percentage for non-users, and total number and odds ratios with 95% confidence intervals for smokeless tobacco users and smokers, compared to non-users

Age (years)	Non-users (n = 23835)*		Smokeless tobacco users (n = 5002)*			Smokers ≥ 15 cigarettes d ⁻¹ (n = 8797)*		
	%	n	n	OR	(95% C.I.)	n	OR	(95% C.I.)
16-35	0.6	65	14	1.0	(0.5-1.7)	24	0.7	(0.4-1.1)
36-45	2.6	130	19	1.3	(0.8-2.1)	44	0.8	(0.6-1.1)
46-55	9.3	422	111	1.7	(1.3-2.1)	139	0.9	(0.7-1.1)
56-65	24.0	1038	389	1.2	(1.1-1.4)	148	0.7	(0.6-0.8)

* Numbers in parenthesis refer to all subjects in the tobacco group for whom blood pressure were available.

Higher prevalences of elevated blood pressure became significantly evident during the fifth decade of life. Smokeless tobacco users were at higher risk of hypertension than non-users, whereas smokers were at lower risk than non-users in all age groups.

To investigate the effect of body weight on blood pressure, subjects with BMI of < 22, 22-26 and > 26 were analysed separately. Hypertension was more common in obese subjects in all tobacco and age groups. The estimated odds ratio on comparing smokeless tobacco users and smokers with non-users in the same BMI category only showed small changes compared to the value obtained when BMI was not checked.

Heart rate at rest was dichotomized to > 80 beats min⁻¹ or less. At young ages (≤ 45 years) only smokers had a higher prevalence of heart rate (> 80 beats min⁻¹), with an odds ratio of 1.6 (C.I., 1.5-1.7). In older age groups (> 45 years), both smokeless tobacco users and smokers had equally high prevalence of high heart rate, with an odds ratio of 1.4 (C.I., 1.3-1.6) compared to non-users.

Discussion

The results of the present study confirm previous knowledge of the health consequences of cigarette smoking, and also incorporate new findings regarding the health status of a large group of smokeless tobacco users.

The overall impression is that smokers generally face more hazards, whatever the symptoms or signs investigated. Smokeless tobacco users appear to have a better general health profile than those who use smoked tobacco, although their profile is worse than that of the non-users. This finding contrasts with the

higher risk of disability pensions for cardiovascular and musculoskeletal reasons in both smokers and smokeless tobacco users, compared to non-users.

Confounding factors

There might be a bias in the selection of workers represented in this study, as about 25% did not report for the examination, or were not reached by the invitation. There is no reason to believe that the differences between tobacco users and non-users observed among the examined groups would be overestimated compared to those who were not examined, as the probability of reporting for the examination is presumably independent of both tobacco habits and the studied variables.

Tobacco users tend to have higher risk life styles than non-users, and a higher intake of alcohol is usual among tobacco users [4], and could influence the incidence of both musculoskeletal and cardiovascular diseases. However, there is a high degree of scientific reliability in regarding smoked tobacco as a causal factor in cardiovascular disease, and it seems unlikely that the higher risks among smokeless tobacco users could be explained solely by exposure to risk factors other than tobacco.

Cardiovascular disorders

Circulatory symptoms were generally quite infrequent in this working population. The construction industry demands high-level physical performance, thus eliminating subjects with decreased performance capacity, and giving a healthy worker effect with a biased selection of more fit workers in older age groups. This may explain why fewer smokers are present in the older age groups, and why

some symptoms and cardiovascular risks were less prevalent in the oldest group than in the middle age group.

Owing to a high level of exposure to vibrations from handtools, traumatic vasospastic disease of the hands ('white fingers') was quite common among these workers, and was significantly more common among both smokers and smokeless tobacco users. In a study by Ekenvall [22], the smokeless tobacco users had as high a prevalence of symptoms as the smokers, thus implicating nicotine as an important pathophysiological factor in aggravating this disorder.

The higher prevalence of elevated blood pressure among smokeless tobacco users, compared to both smokers and non-users, was the most significant result of this study. A few studies, mainly observations of young athletes or single case reports [23-28], have suggested a blood pressure-elevating effect due to the use of smokeless tobacco. Some review articles [29, 30] have also suggested such an association. To our knowledge, our observations are the first from a study of a larger population of all working ages with a group of exclusive smokeless tobacco users that provide support for such a link. It could be postulated that this might be due to the prolonged exposure to nicotine, as a consequence of a longer period of absorption compared to smoking [12]. The absence of simultaneous exposure to carbon monoxide when using smokeless tobacco could also be of importance.

One difference between smokeless tobacco and cigarettes is the sodium content of smokeless tobacco (c. 2% of the wet weight), which has been suspected of influencing the blood pressure. Smokeless tobacco users have been shown to excrete higher amounts of sodium in the urine than non-users [31, 32]. Liquorice, often used for flavouring in US smokeless tobacco, is not usually used in Swedish moist snuff.

The higher risk of early retirement due to cardiovascular disease among both smokeless tobacco users and smokers supports the view that nicotine might have an important role in causing cardiovascular damage. The observation that hypertension is a more common cause of early retirement among smokeless tobacco users, although the number of cases is small and should be interpreted with caution, is consistent with the higher prevalence of hypertension found in this group, thus supporting the hypothesis that smokeless tobacco use might have a more hypertensive effect than the use of smoked tobacco.

Gastrointestinal disorders

The decreased duodenal bicarbonate secretion induced by intravenously administered nicotine is thought to contribute to the development of peptic ulcer [15, 16]. In this study, the smokers showed a significantly higher risk of peptic ulcer and also of heartburn, as found in earlier studies. Smokeless tobacco users did not display a similar excess risk, and had a significantly lower tendency to suffer from heartburn than non-users. This finding was consistent in all 12 occupational subgroups. There is no clear-cut explanation for this result. Moist Swedish snuff has a high pH of 8.5, which could be of importance when saliva is swallowed. Another unknown factor is a possible personality difference between smokeless tobacco users and smokers.

Body mass index

Smokers exhibited a lower BMI, as expected, whereas smokeless tobacco users tended to be more obese than non-users. The reason for this finding might of course be behavioural. Smoking often becomes an alternative to eating when hungry, whereas the use of smokeless tobacco is perhaps less likely to interfere with eating. However, the metabolic effects of nicotine could be complex. In a study of smoking habits and body weight by Jacobs [33], smokers generally had a lower body weight, but the results represented a U-shaped curve in which consumers of large amounts of tobacco, i.e. > 30 cigarettes daily, showed an increased body weight compared to non-users. Perhaps the larger total amount of nicotine absorbed by smokeless tobacco users produces effects on body weight that are more similar to those found in very heavy smokers.

Orthopaedic disorders

Recent studies of orthopaedic back problems have demonstrated an association between smoking habits and a higher incidence of back disorders and osteoporosis [17, 34]. A reduced capacity for diffusion to the intervertebral discs due to fewer nutritional capillaries in the vertebral spine has been observed [19]. It has been suggested that this is due to nicotinic effects. The results of this study confirm that there is a higher rate of back disorder symptoms among smokers, but although smokeless tobacco users did not show a similar excess risk in low back

pain symptoms, they were granted disability pensions due to musculoskeletal disorders twice as often as the non-users, i.e. with the same frequency as in smokers.

Conclusions

It is concluded from the results of this study that nicotine administered through the buccal mucosa, in the form of smokeless tobacco, has consequences for different organ systems which differ, to some extent, from those associated with the use of smoked tobacco. However, the cardiovascular risks appear to be so important, that even without further evidence, patients with cardiovascular disorders should be actively advised to avoid smokeless tobacco as an alternative when ceasing smoking.

Our data also highlight the need for further information on the long-term consequences for morbidity and mortality in different cardiovascular diseases in smokeless tobacco users. More detailed analyses of the effects of smokeless tobacco on the development and treatment of hypertension, angina pectoris, myocardial infarction and atherosclerosis are urgently needed.

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References

- 1 Swedish Tobacco Company, Box 17007, S-104 62 Stockholm, Sweden. *Annual Report 1990*.
- 2 US Department of Health, Education and Welfare 1979; Smoking and Health. *A Report of the Surgeon General*. DHEW Publication No (PHS) 79-50066, 1979a.
- 3 Seltzer CC. Effect of smoking on blood pressure. *Am Heart J* 1974; **87**: 558-64.
- 4 Gynellberg F, Meyer J. Relationship between blood pressure and physical fitness, smoking and alcohol consumption in Copenhagen males aged 40-59 years. *Acta Med Scand* 1974; **195**: 375-80.
- 5 Friedman GD, Klatsky AL, Siegelaub AB. Alcohol, tobacco and hypertension. *Hypertension* 1982; **III-4**: 143-50.
- 6 Green MS, Jucha E, Luz Y. Blood pressure in smokers and nonsmokers: epidemiologic findings. *Am Heart J* 1986; **III**: 932-40.
- 7 Astrup P, Kjeldsen K. Carbon monoxide, smoking and atherosclerosis. *Med Clin North Am* 1973; **58**: 323-50.
- 8 Che Su. Actions of nicotine and smoking on circulation. *Pharmacol Ther* 1982; **17**: 129-41.
- 9 Ahmed SS, Moschos CB, Lyons MM *et al*. Cardiovascular effects of long-term cigarette smoking and nicotine administration. *Am J Cardiol* 1976; **37**: 33-40.
- 10 Ingenito AJ. A pharmacological perspective on smoking and cardiovascular diseases. *Trends Pharmacol Sci* 1980; **1**: 448-52.
- 11 US Department of Health and Human Services, 1986. The health consequences of using smokeless tobacco. *A Report of the Advisory Committee to the Surgeon General*. NIH Publication No 86-2874, April 1986b.
- 12 Benowitz NL, Porchet H, Sheiner L, Jacob P. Nicotine absorption and cardiovascular effects with smokeless tobacco use: comparison with cigarettes and nicotine gum. *Clin Pharmacol Ther* 1988; **44**: 23-8.
- 13 Ramström LM, Tibblin H. Tobaksvanor i Sverige 1988. Resultat från NTS-undersökningen 1988. *Tema tobak, serie av småskrifter från NTS*. Stockholm 1989 ISSN 0283-7757 (Tobacco habits in Sweden 1988. Results from the NTS-study 1988).
- 14 US Department of Health, Education, and Welfare. 1972. The health consequences of smoking. *A Report of the Surgeon General*. DHEW Publication No. (HSM) 72-7516.
- 15 Konturek SJ, Dale J, Jacobson ED, Johnson LR. Mechanisms of nicotine induced inhibition of pancreatic secretion of bicarbonate in the dog. *Gastroenterology* 1972; **62**: 425-9.
- 16 Kikendall JW, Eval J, Johnson LF. Effect of cigarette smoking on gastrointestinal physiology and non-neoplastic digestive disease. *J Clin Gastroenterol* 1984; **6**: 65-78.
- 17 Frymoyer JW, Pope MH, Costanza MC, Rosen JC, Goggin JE, Wilder DG. Epidemiologic studies of low back pain. *Spine* 1980; **5**: 419-23.
- 18 Svensson H-O, Vedin A, Wilhelmsson C, Andersson GBJ. Low back pain in relation to other diseases and cardiovascular risk factors. *Spine* 1983; **8**: 277-85.
- 19 Holm S, Nachemson A. Nutrition of the intervertebral disc: acute effects of cigarette smoking. *Ups J Med Sci* 1988; **93**: 91-9.
- 20 Hirsch JM, Heyden G, Thilander H. A clinical, histomorphological and histochemical study on snuff-induced lesions of varying severity. *J Oral Pathol* 1982; **11**: 387-98.
- 21 Woolf B. On estimating the relation between blood group and disease. *Ann Hum Genet* 1955; **19**: 251-3.
- 22 Ekenvall L, Lindblad LE. Vibration-induced white fingers and nicotine, a preliminary report. *Opusc. Med* 1985; **30**: 28-31.
- 23 Squires WG, Brandon TA, Zinkgraf S *et al*. Hemodynamic effects of oral smokeless tobacco in dogs and young adults. *Prev Med* 1984; **13**: 195-206.
- 24 Schroeder KL, Chen MS. Smokeless tobacco and blood pressure. *N Engl J Med* 1984; **312**: 919.
- 25 Ksir C, Shank M, Kraemer W, Noble B. Effects of chewing tobacco on heart rate and blood pressure during exercise. *J Sports Med* 1986; **26**: 384-9.
- 26 McPhaul M, Punzi HA, Sandy A, Borganelli M, Rude R, Kaplan NM. Snuff induced hypertension in pheochromocytoma. *J Am Med Assoc* 1984; **252**: 2860-62.
- 27 Wells DG, Rustick JM. Hypertension from smokeless tobacco. *Anesthesiology* 1986; **65**: 339.
- 28 Adelman RD. Smokeless tobacco and hypertension in an adolescent. *Pediatrics* 1987; **79**: 837-8.
- 29 Connolly GN, Winn DM, Hecht SS, Henningfield JE, Walker B, Hoffman D. The re-emergence of smokeless tobacco. *N Engl J Med* 1986; **314**: 1020-27.
- 30 Ricer RE. Smokeless tobacco use. A dangerous nicotine habit. *Postgrad Med* 1987; **81**: 89-94.

- 31 Hampson NB. Smokeless is not saltless. *N Engl J Med* 1984; 312: 919.
- 32 Benowitz NL. Sodium intake from smokeless tobacco. *N Engl J Med* 1988; 319: 873.
- 33 Jacobs DR, Gottenborg S. Smoking and weight: the Minnesota Lipid Research Clinic. *Am J Public Health* 1981; 71: 391-6.
- 34 Seeman E, Melton LJ, O'Fallon WM, Riggs BL. Risk factors for spinal oestoporosis in men. *Am J Med* 1983; 75: 977-83.

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